

Biology 30

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June 1998

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Grade 12 Diploma Examination

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Biology 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 48 multiple-choice and 8 numerical-response questions, of equal value, worth 70% of the examination
- 2 written-response questions, of equal value, worth 30% of the examination
- 80 total possible marks, worth 100% of the examination

This examination contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

Tear-out data pages are included near the back of this booklet.

The blank perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

- A. biology
- B. physics
- C. chemistry
- D. science

Answer Sheet

-
- Ⓐ
- Ⓑ
- Ⓒ
- Ⓓ

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.

(Round and record your answer to three significant digits in the numerical-response section of the answer sheet.)

$$\begin{aligned}\text{Average} &= (21.0 + 25.5 + 24.5)/3 \\ &= 23.666\dots \\ &= 23.7\end{aligned}$$

Record 23.7 on the answer sheet →

2	3	.	7
---	---	---	---

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Correct-Order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____.
(Record all four digits in the numerical-response section of the answer sheet.)

- 1 physics
- 2 chemistry
- 3 biology
- 4 science

Answer 3214

**Record 3214 on the
answer sheet** →

3 2 1 4



Selection Question and Solution

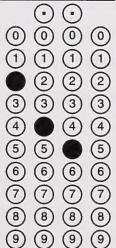
The birds in the following list are numbered _____.
(Record your answer in lowest-to-highest numerical order in the numerical-response section of the answer sheet.)

- 1 dog
- 2 sparrow
- 3 cat
- 4 robin
- 5 chicken

Answer 245

**Record 245 on the
answer sheet** →

2 4 5



Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and explicit.
- Descriptions and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.



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While animals interact with their external environment, their nervous and endocrine systems maintain internal equilibrium. The study of organisms and of disease processes has helped extend our knowledge of these systems.

Use the following information to answer the next question.

The symptoms of Alzheimer's disease gradually appear as affected individuals age. One symptom of Alzheimer's disease is a loss of memory. Studies have shown that the administration of the hormone estrogen to female patients with Alzheimer's disease dramatically improved their memory.

—from *Calgary Herald, 1996*

1. It appears that the hormone estrogen has an effect on the

- A. cerebrum
- B. cerebellum
- C. hypothalamus
- D. medulla oblongata

Use the following information to answer the next question.

After a head injury, a mountain biker was assessed by a doctor. One of the tests the doctor did was to gently tap just below her kneecap. Also, he shone a light into each of her eyes and made observations. In both tests, he was trying to quickly rule out any neurological damage.

2. Assume that the biker's nervous system was not injured and that the biker's body responded in a normal way to the gentle tap. The neurological pathway that was followed when this response was elicited was

- A. receptor, sensory neuron, interneuron, motor neuron, effector
- B. effector, sensory neuron, interneuron, motor neuron, receptor
- C. receptor, motor neuron, interneuron, sensory neuron, effector
- D. effector, motor neuron, interneuron, sensory neuron, receptor

Use the following information to answer the next question.

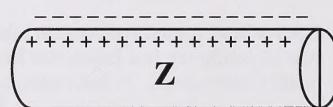
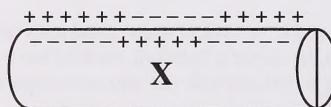
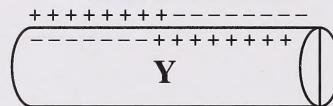
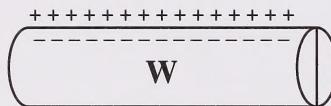
Diving improperly into a swimming pool or into a lake may cause injuries that damage the spinal cord. The victims of these injuries often suffer loss of the sensation of heat and touch on the skin and paralysis of muscles below the site of the injury.

3. Paralysis of muscles below the site of a spinal cord injury is often permanent because neurons in the grey matter of the spinal cord all lack a

- A. nucleus
- B. dendrite
- C. cell body
- D. neurilemma

Use the following information to answer the next question.

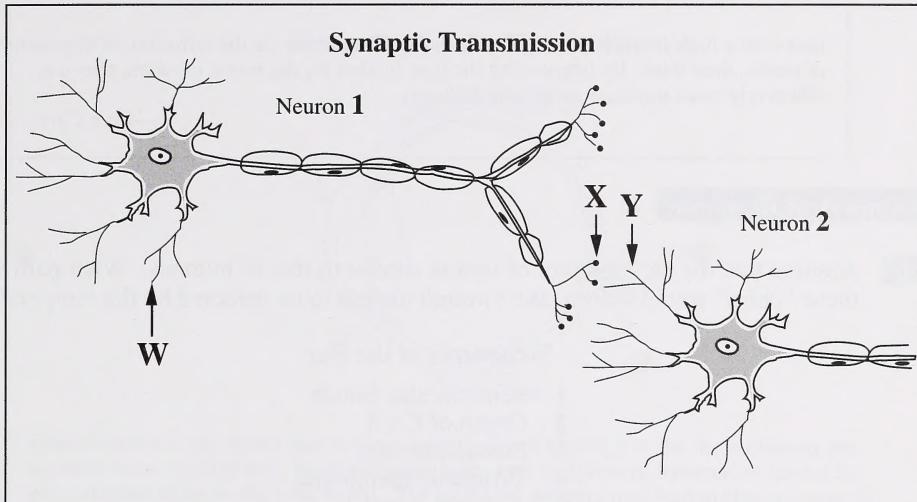
Sections of Axons



4. The resting axon is labelled

- A. W
- B. X
- C. Y
- D. Z

Use the following information to answer the next question.



5. Destruction of the synaptic vesicles of Neuron 1 will

- A. block the nerve impulse at W
- B. cause X to be constantly stimulated
- C. prevent depolarizations from occurring at Y
- D. result in the action of cholinesterase in Neuron 2

Use the following information to answer the next question.

Bats emit a high-frequency “chirp” as they fly. They listen for the reflection of this sound off of moths, their food. By interpreting the time it takes for the sound to return, they can effectively catch moths, even in total darkness.

—from *Curtis, 1983*

Numerical Response

1. Assume that the ear structure of bats is similar to that of humans. What pathway would these “chirp” sound waves take through the ear to be detected by the temporal lobe?

Structures of the Ear

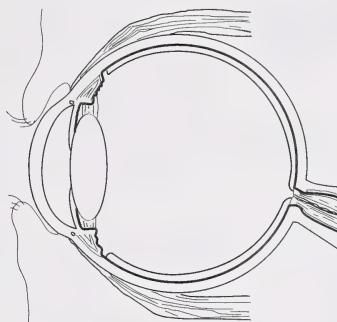
- 1** Semicircular canals
- 2** Organ of Corti
- 3** Eustachian tube
- 4** Tympanic membrane
- 5** Auditory canal
- 6** Ossicles

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____

Use the following information to answer the next two questions.

Cross-section of a Normal Eye



Glaucoma is a vision defect that occurs where there is a blockage of the ducts draining the aqueous humour of the eye. Pressure builds in the eye, and sensory information cannot be relayed to the brain by the optic nerve. The increased pressure may lead to blindness due to damaged optic nerves.

—from *Taber, 1989*

6. When glaucoma occurs, the part of the cerebrum that does **not** receive visual information is the

- A. frontal lobe
- B. parietal lobe
- C. occipital lobe
- D. temporal lobe

Use the additional information to answer the next question.

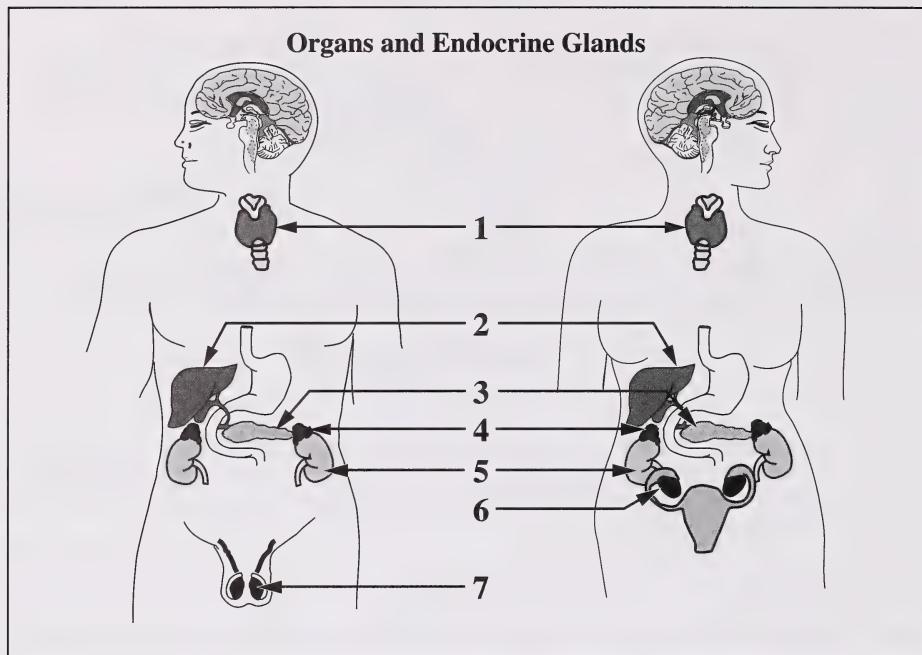
Retinal detachment is a disorder of the eye that is closely related to aging. It may also be the result of a direct injury to the eye. In this disorder, sections of the retina become separated from the layer behind it. Fluid fills the resulting spaces.

—from *Taber, 1989*

7. Blindness due to optic nerve damage and blindness due to retinal detachment are similar because they **both**

- A. involve damaged receptors
- B. affect blood flow to the eye
- C. involve damaged occipital lobes
- D. affect nerve impulse transmission to the brain

Use the following information to answer the next four questions.



8. The gland that is directly stimulated by the nervous system to secrete hormones is the structure labelled

- 2
- 3
- 4
- 5

9. The structure that produces only hormones is labelled

- 1
- 2
- 5
- 6

10. A target organ for aldosterone is the structure labelled

- 3
- 5
- 6
- 7

11. A patient is suffering from weight gain, sluggishness, and dry skin. The patient is injected with a tracer, radioactive iodine, to identify the structure responsible for these symptoms. The tracer would **most likely** accumulate in the structure labelled

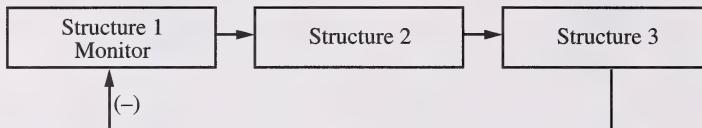
- A. 1
- B. 2
- C. 4
- D. 7

12. When the hypothalamus fails to produce ADH, the physiological effect that is **most likely** is

- A. muscle spasms
- B. loss of memory
- C. decreased breathing rate
- D. increased urine production

Use the following information to answer the next question.

Example of a Negative Feedback Loop



13. If the physiological factor influencing this negative feedback loop were the metabolic rate, then 1, 2, and 3, respectively, would be the

- A. hypothalamus, pituitary, and thyroid
- B. thyroid, hypothalamus, and pituitary
- C. pituitary, thyroid, and hypothalamus
- D. pituitary, hypothalamus, and thyroid

14. The response to increased glucose levels in the blood is the conversion of glucose to glycogen. This response is the result of the secretion of

- A. insulin by the adrenal medulla
- B. glucagon by the adrenal medulla
- C. insulin by the islets of Langerhans
- D. glucagon by the islets of Langerhans

15. While playing a vigorous game of basketball, a person's overall rate of metabolism increases. Which two hormone levels rise so that blood glucose levels meet the needs of the increased metabolic rate?

- A. Cortisol and ADH
- B. Steroids and HGH
- C. Insulin and acetylcholine
- D. Epinephrine and glucagon

Use the following information to answer the next two questions.

HGH is a protein. Biosynthetic HGH is used in the treatment of Turner syndrome, a disorder occurring in females as a result of nondisjunction; the sex chromosome complement is XO instead of the normal XX. Untreated females with Turner syndrome grow only to the height of an average ten-year-old.

—from *Leger, 1994*

16. In humans, HGH directly stimulates the

- A. gonads
- B. adrenal glands
- C. muscles and peripheral nerves
- D. long bones and skeletal muscles

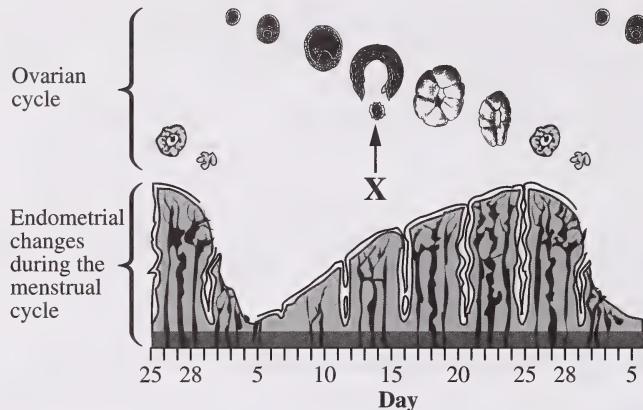
17. Why might nondisjunction produce more serious effects on the population if it were present in gametes produced by a female rather than in gametes produced by a male?

- A. An egg (ovum) is larger than a sperm.
- B. Fewer eggs (ova) are produced than sperm.
- C. An egg mother cell (oogonium) divides twice but a sperm mother cell (spermatogonium) divides only once.
- D. An egg mother cell (oogonium) divides equally but a sperm mother cell (spermatogonium) divides unequally.

Reproductive processes may be affected by disease, the environment, or the use of technology.

Use the following information to answer the next two questions.

Human Ovarian and Menstrual Cycles



—adapted from *BIOLOGY*, 3RD EDITION, by Neil Campbell. Copyright (©) 1993 by the Benjamin/Cummings Publishing Company. Reprinted by permission.

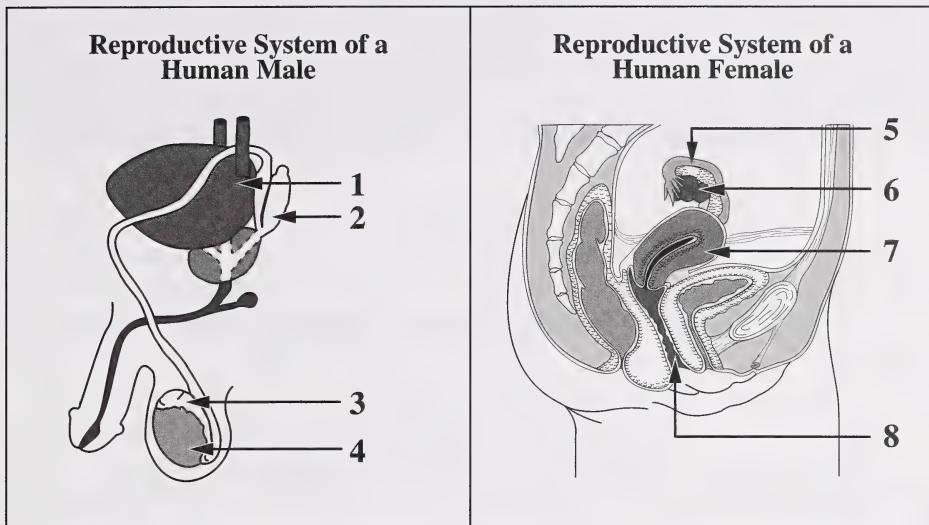
18. Structure X represents

- A. an ovary
- B. a follicle
- C. an oocyte
- D. a corpus luteum

19. A reasonable interpretation of the graph and drawings would be that FSH is beginning to increase at day

- A. 10
- B. 14
- C. 21
- D. 28

Use the following information to answer the next question.



Numerical Response

2. The target organs for FSH in the male and the female are labelled, respectively, _____ and _____.

(Record your **two-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____

20. Birth control pills prevent pregnancy. One form of birth control pill works by mimicking some characteristics of pregnancy. A direct result of using this birth control pill is that during most of the menstrual cycle

- A. increased and sustained levels of LH are released from the pituitary
- B. increased and sustained levels of FSH are released from the pituitary
- C. progesterone and estrogen levels are maintained at a relatively low level
- D. progesterone and estrogen levels are maintained at a relatively high level

21. Which of the following statements about normal human fertilization is **correct**?

- A. Fertilization occurs in the uterus of the woman.
- B. Fertilization occurs in a simple, one-step process.
- C. Fertilization involves the use of enzymes by sperm.
- D. Fertilization involves the replication of chromosomes.

22. Which hormone induces uterine contractions?

- A. Relaxin
- B. Prolactin
- C. Oxytocin
- D. Progesterone

Use the following information to answer the next question.

Events That Occur When Lactation is Initiated by the Feeding Action of a Baby

- 1 Release of oxytocin into the blood
- 2 Transmission of nerve impulses to the hypothalamus
- 3 Contraction of smooth muscle in the gland
- 4 Stimulation of sensory nerve endings in the breast

Numerical Response

3. The sequence of events that occurs when lactation is initiated by a baby is _____.

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____

The study of cell division, chromosome composition, and the structure and function of DNA increases understanding of growth, genetic continuity, and diversity of organisms.

Use the following information to answer the next two questions.

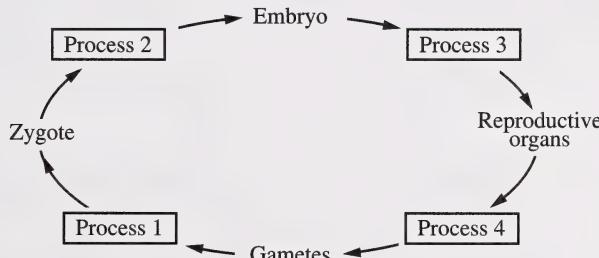
Organism	Chromosome Number (2n)
Horse	66
Dog	78
Cat	38
Human	46

23. Which of the following statements about cell types and chromosome numbers is **correct**?

- A. The ovum of a horse contains 66 chromosomes.
- B. A somatic cell of a cat contains 76 chromosomes.
- C. The spermatid of a dog contains 39 chromosomes.
- D. A somatic cell of a human contains 23 chromosomes.

Use the additional information to answer the next question.

The Life Cycle of the Horse



24. Which process illustrates reduction division, as in spermatogenesis?

- A. Process 1
- B. Process 2
- C. Process 3
- D. Process 4

Use the following information to answer the next question.

Some Events That Occur During Cell Division

- 1 Centromeres divide
- 2 Cytokinesis occurs
- 3 Identical cells are produced
- 4 DNA is replicated
- 5 Haploid cells are produced
- 6 Spindle fibres form

Numerical Response

4. Four events that occur in **both** human asexual and sexual cell reproduction are represented by numbers _____.

(Record your **four-digit answer in lowest-to-highest numerical order** in the numerical-response section of the answer sheet.)

Answer: _____

25. In a human cell cycle, the event that occurs before mitosis begins and the event that occurs at or near the completion of mitosis are, respectively,

- A. crossing over and synapsis
- B. cytokinesis and crossing over
- C. replication of DNA and synapsis
- D. replication of DNA and cytokinesis

Use the following information to answer the next question.

During his study of genetics, Gregory Mendel cross-pollinated many pea plants. He recorded the number and types of offspring produced and applied his knowledge of mathematics to create explanations for his observations. He hypothesized that factors are inherited separately and proposed the law of segregation.

26. The modern-day interpretation of Mendel's law of segregation is that

- A. alleles are expressed independently during mitosis
- B. alleles are expressed independently during meiosis
- C. paired alleles separate during mitosis and are distributed into different gametes
- D. paired alleles separate during meiosis and are distributed into different gametes

Use the following information to answer the next two questions.

In cattle, hornless or polled (P) is dominant over the horned (p) condition. This is an autosomal trait. The semen of a polled bull is used to artificially inseminate three cows. Cow 1 (horned) produces a horned calf, cow 2 (polled) produces a horned calf, and cow 3 (polled) produces a polled calf.

27. Which of the cattle **must** have a heterozygous genotype for this trait?

- A. Cow 2 and calf 2
- B. Cow 3 and calf 3
- C. The polled bull and cow 1
- D. The polled bull and cow 2

28. Which of the above cattle could have two possible genotypes?

- A. Cow 1
- B. Cow 2
- C. Cow 3
- D. The polled bull

Use the following information to answer the next two questions.

Four babies were born in a hospital on the same day. Due to a mix-up at the hospital, there was some confusion as to the identity of the babies.

	Mother	Father
Parents 1	Type A	Type O
Parents 2	Type AB	Type B
Parents 3	Type AB	Type O
Parents 4	Type O	Type B

29. Which of the above parents could have a baby with blood type O?

- A. Parents 1 and 3
- B. Parents 1 and 4
- C. Parents 2 and 3
- D. Parents 2 and 4

30. The predicted phenotypic ratio for the children of **parents 3** is

- A. $\frac{1}{2}$ type A and $\frac{1}{2}$ type B
- B. $\frac{1}{2}$ type AB and $\frac{1}{2}$ type O
- C. $\frac{1}{4}$ type A, $\frac{1}{2}$ type O, and $\frac{1}{4}$ type B
- D. $\frac{1}{4}$ type A, $\frac{1}{4}$ type B, $\frac{1}{4}$ type AB, and $\frac{1}{4}$ type O

Use the following information to answer the next two questions.

Assume that there are two gene pairs involved in determining eye colour: one codes for pigment in the front of the iris and the other codes for pigment in the back of the iris.

If the genotype is	then the eye colour is
$AABB$	black-brown
$AABb$	dark brown
$AAAb$	brown
$AaBB$	brown-green flecked
$AaBb$	light brown
$Aabb$	grey-blue
$aaBB$	green
$aaBb$	dark blue
$aabb$	light blue

—from Audesirk, 1996

31. A man has grey-blue eyes and a woman has green eyes. Which eye colour phenotypes would be possible for children born to this man and woman?

- A. Grey-blue and green
- B. Dark blue and brown
- C. Light brown and dark blue
- D. Brown-green flecked and light blue

Numerical Response

5. If one parent has light brown eyes and the other has dark brown eyes, what is the probability that they would have an offspring with grey-blue eyes?

(Record your **answer as a percentage to three digits** in the numerical-response section of the answer sheet.)

Answer: _____ %

Use the following information to answer the next three questions.

Scientists have identified a genetic condition that apparently makes some men prone to impulsive, violent behaviour. A pedigree was drawn highlighting the violent members of a particular family. It appeared, from the pedigree, that men who displayed this violent behaviour inherited this condition from their mothers, not their fathers. Further evidence showed that this was the mode of inheritance.

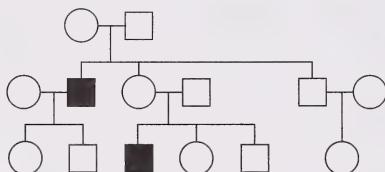
—from Richardson, 1993

32. The inheritance pattern described indicates that this condition is

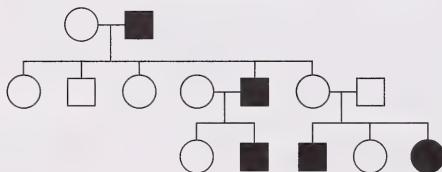
- A. X-linked
- B. Y-linked
- C. autosomal
- D. codominant

33. Which of the following pedigrees is **not** possible for the above condition?
(Note: Carriers have not been identified.)

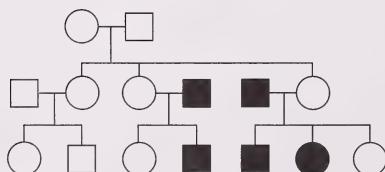
A.



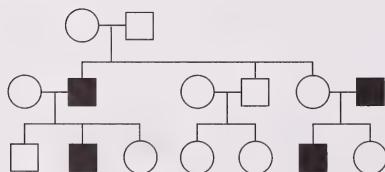
B.



C.



D.



Use the additional information to answer the next question.

Researchers found that the allele that caused violent behaviour was situated on a chromosome in a region that codes for an enzyme responsible for breaking down neurotransmitters in the brain.

—from *Richardson, 1993*

34. The substance affected by the genetic defect could be

- A. ACTH
- B. acetylcholine
- C. cholinesterase
- D. norepinephrine

Use the following information to answer the next two questions.

Two alleles (H^B and H^N) exist for the pattern baldness gene. The H^B allele is dominant in men but recessive in women. The H^N (normal) allele is dominant in females but recessive in males. A single H^B allele seems to cause pattern baldness only in the presence of the level of testosterone normally found in adult males. Males will develop pattern baldness with the genotypes $H^B H^N$ or $H^B H^B$; whereas, for females to develop pattern baldness, they must inherit two H^B alleles. It appears that testosterone destroys or inhibits the production of an enzyme necessary for hair growth in the hair follicle.

—from *Hoffman and Lingna, 1995*

35. The difference in expression of pattern baldness in women and men results from the pattern baldness gene's being

- A. X-linked
- B. Y-linked
- C. independent of hormonal balance
- D. influenced by the level of testosterone

36. Parents who do not display pattern baldness have a son who exhibited pattern baldness by the age of thirty. If they also have a daughter, she has

- A. no chance of going bald, as the $H^B H^B$ genotype is not possible
- B. no chance of going bald, as the $H^B H^N$ genotype is not possible
- C. a 1 in 3 chance of going bald, as the $H^B H^N$ genotype is possible
- D. a 1 in 2 chance of going bald, as the $H^B H^B$ genotype is possible

Use the following information to answer the next question.

In *Drosophila* (fruit flies), the genes for pink eyes, rough eyes, curled wings, and hairless bristles are located on chromosome 3.

Genes	Crossover Frequency	Legend
• pink eyes and hairless bristles	21.5	Pink eyes – 1
• hairless bristles and curled wings	19.5	Rough eyes – 2
• rough eyes and curled wings	41.1	Curled wings – 3
• pink eyes and rough eyes	43.1	Hairless bristles – 4
• rough eyes and hairless bristles	21.6	

—from *Griffiths, 1993*

Numerical Response

6. Use the legend to indicate the order of these genes along a chromosome.

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____ (There are two possible ways of recording the answer; either will be acceptable.)

Numerical Response

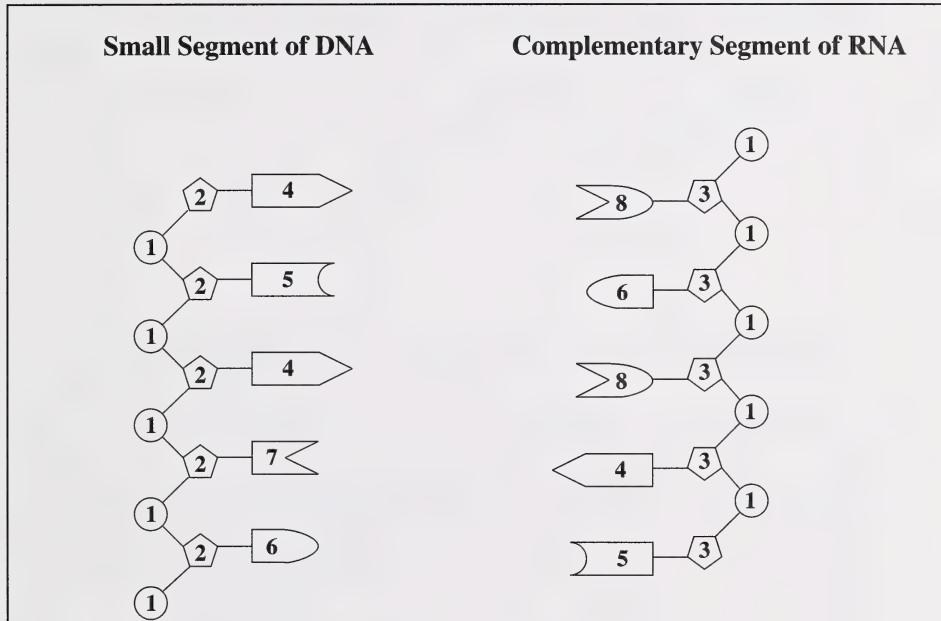
7. In a large population of randomly breeding *Drosophila*, 1% of the population exhibits burgundy eye colour, an autosomal recessive trait. According to the Hardy–Weinberg equilibrium, what **percentage** of the population is expected to be heterozygous?

(Record your **answer as a whole number percentage**, in the numerical-response section of the answer sheet.)

Answer: _____ %

The study of cell division, chromosome composition, and the structure and function of DNA increases understanding of growth, genetic continuity, and diversity of organisms.

Use the following information to answer the next question.



37. If structure 4 is adenine, then structure 8 is

- A. uracil
- B. adenine
- C. thymine
- D. cytosine

Use the following information to answer the next question.

The DNA sense strand shown below is thought to contain the genetic code for part of an enzyme that speeds up the breakdown of alcohol in the liver. (Read the DNA beginning at the left.)

—A—A—G—G—G—C—C—T—T—A—T—C—

38. Which amino acid sequence would be found in a polypeptide that is produced using the coded information in the above DNA sense strand?

- A. Leucine – glycine – glutamate
- B. Phenylalanine – proline – glutamate
- C. Leucine – glycine – glutamate – tyrosine
- D. Asparagine – proline – valine – methionine

Use the following information to answer the next question.

Between 50 000 and 100 000 genes are involved to build, run, and maintain a human body. Any one of these genes can mutate.

If geneticists locate a harmful mutation, there is hope that one day they will be able to repair the gene both in the affected individual and in his or her gametes.

—from *Turner, 1996*

39. The technology to replace genes in cells of humans is called

- A. gene cloning
- B. gene therapy
- C. carrier screening
- D. DNA fingerprinting

Use the following information to answer the next three questions.

The polymerase chain reaction technique (PCR) makes it possible to produce a large number of copies of a specific DNA sequence in a relatively short time. When heated to 94°C, double-stranded DNA molecules separate completely, forming two single strands. Later, after the temperature is lowered and with DNA polymerase present, complementary DNA strands form. The process of heating and cooling can be repeated to produce as many copies of the DNA as is required.

—from *Klug and Cummings, 1997*

40. If a DNA triplet is CTA, then the complementary DNA triplet is

- A. GAU
- B. GAT
- C. CUA
- D. CTA

41. PCR is similar to a process that normally occurs in cells prior to cell division. The row that identifies the site and name of this process is

Row	Site	Process
A.	nucleus	replication
B.	nucleus	transcription
C.	cytoplasm	replication
D.	cytoplasm	transcription

42. Which enzymes would a geneticist use to cut DNA into fragments?

- A. Ligase enzymes
- B. RNA polymerases
- C. DNA polymerases
- D. Restriction enzymes

Use the following information to answer the next four questions.

In some humans, the liver is unable to produce the enzyme called fumarylacetoacetate hydrolase (FAH). Without this enzyme, the liver is damaged over time because of the accumulation of the toxin succinylacetone. This toxin is produced through the improper metabolism of amino acids. It has been found that livers damaged by succinylacetone actually contain small patches of undamaged cells. These cells produce FAH.

Mice also suffer from liver damage caused by FAH deficiency. Researchers successfully used the following two methods to regenerate normal functioning livers in FAH-deficient mice.

- I. Researchers transplanted some healthy liver cells into the unhealthy livers of the mice.
- II. Researchers inserted normal genes into the damaged livers of the unhealthy mice.

—from *Travis, 1996*

43. The **most likely** explanation for the success following the transplant of healthy cells in mice is that the healthy cells

- A. produced antibodies that repair the damaged cells
- B. transferred FAH-producing genes to the damaged liver
- C. underwent meiosis more rapidly than the damaged cells
- D. produced enough FAH enzyme to restore the function of the liver

44. Which of the following statements about cells is demonstrated by this research?

- A. Genes control cell division in liver cells.
- B. Genes control the production of the FAH enzyme in cells.
- C. Liver cells in an individual are genetically identical to each other.
- D. Liver cells cannot regenerate themselves by the process of mitosis.

45. The presence of patches of healthy cells in the damaged human livers may indicate that

- A. enzymes are not normally coded for by genes in liver cells
- B. liver cells in an individual can undergo genetic change and cell division
- C. liver cells migrated into the damaged livers from other places in the body
- D. enzymes are produced in various places in the body and then migrate into the liver

Numerical Response

8. The sequence of events that produces the enzyme FAH (a protein) in liver cells is _____.

- 1 tRNA transports amino acids to the ribosome
- 2 information from DNA is used to form mRNA
- 3 mRNA carries the message to the ribosome
- 4 ribosome encounters a terminator (stop) codon

(Record your **four-digit answer** in the numerical-response section of the answer sheet.)

Answer: _____

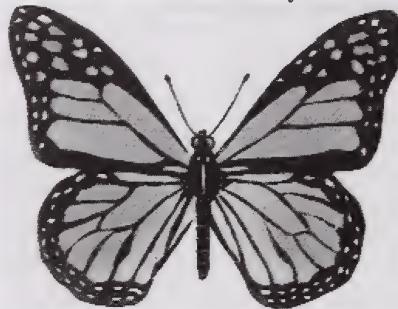
Communities are made of populations, which may reach equilibrium or change over time.

Use the following information to answer the next two questions.

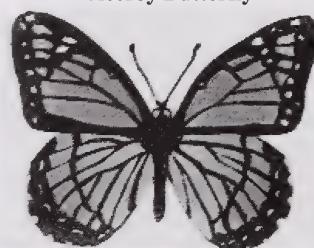
Monarch butterflies lay their eggs on the leaves of milkweed plants. When the eggs hatch, the larvae that emerge feed on the leaves, which are rich in cardiac glycosides. As larvae eat the leaves, these chemicals are incorporated into their tissues and remain there through pupation and into the adult stage. In many animals, these chemicals activate a nerve centre that induces vomiting. Predators quickly learn to avoid the brightly striped caterpillar and stunning black and orange butterfly. This affords protection to larvae and adults.

The viceroy butterfly closely resembles the monarch butterfly in shape and coloration. Its life cycle does not include the milkweed plant; thus, it is safe for animals to eat.

Monarch Butterfly



Viceroy Butterfly



—from Postlethwait, 1992

46. Birds will not eat the viceroys if they have

- A. tried to eat a viceroy and found it indigestible
- B. eaten the larvae of the monarchs and recognize the taste
- C. tasted the monarchs, which causes them to avoid viceroys
- D. consumed many monarchs and are being gradually poisoned

47. To reduce predation, the timing of an adult viceroy's emergence from its cocoon should be

- A. after that of the monarch, to allow the predators to learn the warning signs
- B. simultaneous with that of the monarch, to ensure saturation of the food supply
- C. before that of the monarch, to ensure that the predator's search pattern avoids them
- D. simultaneous with that of the monarch, to allow the predators to learn both patterns

48. Which natural disturbance would **most likely** initiate primary succession in a certain area?

- A. Land exposed when a glacier melted
- B. An entire forest destroyed by disease
- C. Natural vegetation removed by a flood
- D. Grasslands burned by a lightning strike

Use the following information to answer the next question.

As part of the Eastern Slopes Grizzly Bear Project, a research group was formed in 1994 to assess the impact of human action on grizzly bears (*Ursus arctos horribilis*) in the Bow River Watershed. This study area includes land in Central Alberta Rocky Mountain regions such as Banff National Park and Kananaskis Country. The project focuses on mapping grizzly bear habitat across park boundaries and examining the effects of development and land use on bear behaviour and survival.

There are about 800 grizzly bears in Alberta of which about 60 roam within the 6 641 km² of Banff National Park. There are no estimates for the entire Bow River Watershed study area. Grizzly bears live to between 10 and 20 years and begin to reproduce at an average age of six years. Their litter size is about two cubs, once every three years. Cubs grow to between 150 and 400 kg.

Findings of the Eastern Slopes Grizzly Bear Project have shown that although mountain parks have historically been considered major refuge areas for grizzly bears, only a small area of the critical habitat needed for raising cubs remains. Future development of Rocky Mountain townsites such as Banff, Lake Louise, and Canmore may further reduce the range of these bears. The range necessary for the survival of an individual adult male bear needs to be approximately 2 000 km²/bear, however females roam over a considerably smaller area.

—from *Marty, 1997*

Written Response – 15% (12 marks)

(1 mark)

1. a. Calculate the population density of grizzly bears in Banff National Park.

(2 marks)

b. *Suppose that about one-quarter of the grizzly bear population in Banff National Park are adults, and about one-half of the adults are males. Analyze the data on the grizzly population and range size in Banff National Park. Suppose that future developments restricted grizzlies only to this area; then write a conclusion about the survival ability of adult male bears in Banff National Park. (Show your calculations.)*

c. *Grizzly bears have a relatively low biotic potential.*

From the information provided about grizzly bears in Alberta, identify two factors that support this statement and explain how they contribute to a low biotic potential. Based on its biotic potential, classify the grizzly bear as an *r*-selected or *K*-selected species.

Use the additional information to answer the next question.

Studies show that grizzly bears avoid crossing highways. Female bears will not cross the Trans-Canada Highway at all, nor will they use wildlife crossings or underpasses. As a result, traditional migratory corridors for the Eastern Slopes grizzly bears are restricted, partially isolating them from other grizzly bear populations in neighbouring regions of the Rocky Mountains.

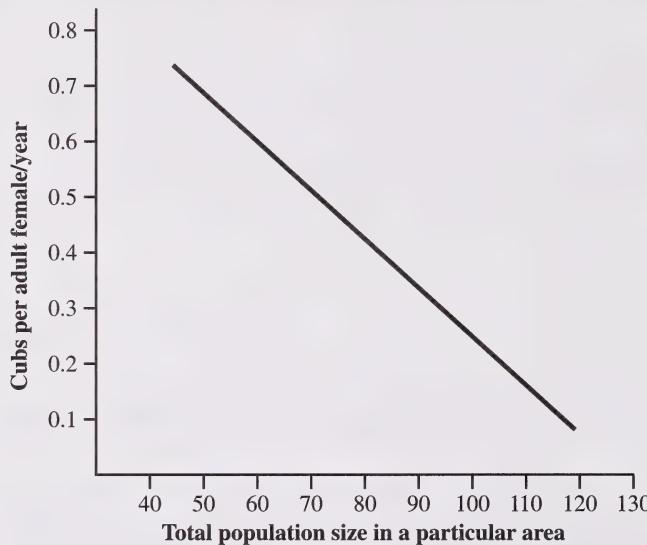
—from *Marty, 1997*

d. Predict the effect of the Trans-Canada Highway on the genetic diversity of the Eastern Slopes grizzly bear population. Explain your prediction.

e. Describe one technology that biologists would use in determining the range and migration routes of the Eastern Slope grizzly bears.

Use the additional information to answer the next two questions.

Reproductive Rate in a Population of Grizzlies in a Particular Area



Note: Assume that the grizzlies in Banff National Park are in an area of similar size to that represented by the graph.

—from *Smith, 1992*

(1 mark)

f. i. Using the graph, predict the current reproductive rate of the grizzly bears within Banff National Park.

(2 marks)

ii. According to the graph, what is the relationship between the number of adult grizzly bears in a population and reproductive rate? Describe one factor that could account for this relationship.

Use the following information to answer the next question.

For 17 years, Elke and Mario Archangel, a Canadian couple living in New York City, tried to have a baby. Elke was 52-years-old and had already experienced menopause when she finally became mother of twins.

When Elke was 35-years-old, she was diagnosed with early stage cervical cancer and was treated successfully. At that time, her doctor performed an operation to widen the opening of her cervix and advised her that she could still have children. Elke and Mario decided to have a baby; however, after two years they were still unsuccessful. They were sent to fertility specialists. On their advice, Elke began to take hormones to regulate and enhance her reproductive cycle. Later, she developed breast cancer and had both breasts removed. She was warned that continuing hormone therapy in an attempt to get pregnant could stimulate further growth of cancerous tumors, but the couple continued to try to have a baby. After approximately 10 years of reproductive problems, Elke and Mario contacted adoption agencies.

Applications for adoption were refused because of their ages and Elke's history of cancer. The couple were accepted into an *in vitro* fertilization program, but the program was not successful. During this time, Elke went through menopause.

A donor was then found to supply multiple eggs for another attempt at *in vitro* fertilization. The donor underwent hormone therapy to stimulate egg production. Elke was also given hormones to prepare her to receive some pre-embryos, and on the second attempt, she became pregnant. After all of the other expenses for treatment, Elke and Mario could no longer afford regular medical care during the pregnancy. In the eighth month of pregnancy, an emergency caesarean section was performed. A girl affected with Down syndrome and a boy unaffected by a genetic disorder were born.

—from *Fortino, 1994*

Written Response – 15% (12 marks)

2. Write a unified essay that addresses aspects of fertility as introduced by Elke and Mario's story.

- **Identify** two possible causes of infertility in men or in women and **explain** how each prevents or reduces the chance of pregnancy.
- **Identify** ethical or societal issues raised by this story and **evaluate** them. (An evaluation includes at least **one** pro and **one** con.)
- Trisomy 21 is a cause of Down syndrome. **Define** what trisomy means and **explain** how it occurs. A diagram may be used to enhance your answer.
Describe a technological procedure that could have been used to determine the genetic health of the fetuses before birth.

.....
.....
.....

*You have now completed the examination.
If you have time, you may wish to check your answers.*

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WR1 Graph adapted from McCullough, D.R. Population dynamics of the Yellowstone grizzly. Fowler, C.W. and T.D. Smith, eds. 1981. *Dynamics of Large Mammal Populations*. New York: John Wiley & Sons, Inc., 1981. Reprinted by permission of John Wiley & Sons, Inc. All Rights Reserved.

BIOLOGY DATA

Symbols

Symbol	Description	Symbol	Description
D_p	population density	σ	male
N	numbers of individuals in a population	φ	female
A	area, space, or volume occupied by a population	n	chromosome number
t	time	B, b	alleles; upper case is dominant, lower case is recessive
Δ	change	I^A, I^B, i	alleles, human blood type (ABO)
r	biotic potential OR maximum per capita population growth rate	P	parent generation
K	carrying capacity	F_1, F_2	first, second filial (generation)
$\frac{\Delta N}{\Delta t}$	a change in population size during time interval	p	frequency of dominant allele
$>$	greater than, dominant over	q	frequency of recessive allele
$<$	less than, recessive to		

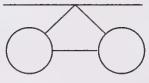
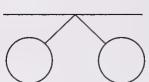
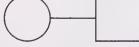
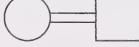
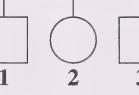
Equations

Subject	Equation
Hardy-Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{A}$
Change in population size	$\Delta N = (\text{factors that increase pop.}) - (\text{factors that decrease pop.})$
Per capita growth rate (time will be determined by the question)	$cgr = \frac{\Delta N}{N}$
Growth rate	$\frac{\Delta N}{\Delta t} = rN$
	$\frac{\Delta N}{\Delta t} = rN \frac{(K - N)}{K}$

Abbreviations for Some Hormones

Hormone	Abbreviation
Adrenocorticotropin hormone	ACTH
Antidiuretic hormone	ADH
Follicle stimulating hormone	FSH
Human chorionic gonadotropin	HCG
Luteinizing hormone	LH (formerly ICSH in males)
Parathyroid hormone	PTH
Prolactin	PRL
Somatotropin (human growth hormone or growth hormone)	STH (HGH or GH)
Thyroid stimulating hormone	TSH

Pedigree Symbols

	Male		Identical twins
	Female		Non-identical twins
	Mating		Affected individuals
	Mating between close relatives		Known heterozygotes for autosomal recessive
I 	Roman numerals symbolize generations		Known carrier of X-linked recessive
II 	Arabic numbers symbolize individuals within a given generation		Deceased individuals
	Birth order, within each group of offspring, is drawn left to right, oldest to youngest		Sex unknown

Messenger RNA Codons and Their Corresponding Amino Acids

First Base	Second Base				Third Base
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA stop **	UGA stop **	A
	UUG leucine	UCG serine	UAG stop **	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG methionine	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartate	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartate	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamate	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamate	GGG glycine	G

* Note: AUG is an initiator codon and also codes for the amino acid methionine.

** Note: UAA, UAG, and UGA are terminator codons.

Information About Nitrogen Bases

Nitrogen Base	Classification	Abbreviation
Adenine	Purine	A
Guanine	Purine	G
Cytosine	Pyrimidine	C
Thymine	Pyrimidine	T
Uracil	Pyrimidine	U

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